



An empirical analysis of price and income elasticities of Papua New Guinea's exports

Giles Dickenson-Jones and Albert Wijeweera

A large body of trade literature focuses on analysing aggregate trade relationships, ignoring the sectoral dynamics. This study estimates both aggregated and disaggregated price and income elasticities of demand for Papua New Guinea's exports. We use co-integration and error-correction techniques under a single-equation functional form, with quarterly data spanning 1994 to 2006. Our results suggest that a long-run equilibrium relationship exists for total exports and for the two subsectors of exports: farming, forestry and fisheries, and minerals and petroleum. The results also suggest that the magnitude of the aggregated elasticities is significantly different from that of the disaggregated exports, implying that subsectors respond differently for identical changes in world prices and economic growth.

Giles Dickenson-Jones is currently employed as an Economist and is a former University of New England Research Student.

Albert Wijeweera is Associate Professor of Economics at The Petroleum Institute, Abu Dhabi, United Arab Emirates.

Papua New Guinea has experienced inconsistent economic development since independence. Although trade has been a major driver of economic growth, its beneficial impact has generally been the result of higher commodity prices and transitory increases in mineral and petroleum export volumes (Baxter 2001). The contrast between potential and performance makes Papua New Guinea's trade a popular and relevant area of focus.

Much of the existing literature attempts to estimate aggregated trade elasticities,

which tend to mask the behaviour of individual sectors. To avoid this shortcoming, we estimate both aggregated and disaggregated export demand elasticities for Papua New Guinea's mineral and petroleum sector and its non-mineral sector. In addition, long-run and short-run elasticities are estimated using a co-integrated framework.

Papua New Guinea's exports have been divided into two sectors: petroleum and mineral exports (hereafter referred to as the mineral sector) and farming, forestry and fishery exports (hereafter, the non-



mineral sector). A single-equation export demand function is used to estimate the disaggregated export price and income elasticities, which are compared with the estimated aggregated elasticities. We use quarterly trade data from 1994 to 2006 and apply the Engle and Granger (1987) two-step co-integration procedure to estimate the export demand elasticities.

Section two of this article reviews the previous literature on the topic. Section three provides historical, institutional and economic backgrounds with particular reference to Papua New Guinea's exports. The methodology and data sources used in the analysis are detailed in section four; while section five discusses the findings and section six concludes.

Literature review

The view that trade openness can provide an important stimulus for economic growth has meant that a large amount of attention has been paid to the empirical modelling of trade (Edwards 1991). Key areas of focus have been whether currency devaluation will improve the balance of trade and how a country can most effectively benefit from trade.

Trade theory suggests that world demand for a country's exports is dependent on the relative price of their exports and the incomes of importers (Murray and Ginman 1975; Paulino and Thirlwall 2004). Because of the importance of price elasticities to trade policy, it is often the key area of focus. The work of Houthakker and Magee (1969) argues, however, that income elasticities are of equal importance.

Senhadji and Montenegro (1999) estimated export demand elasticities for a group of 53 industrial and developing countries for the period 1960–93. They found that price elasticities were more elastic over time and were lower for

developing countries than for industrial countries. Income elasticities of demand were found to be the highest in Asia, implying that exports were an engine of growth for the region. Bahmani-Oskooee and Kara (2005) estimated export demand equations for 28 countries for the period 1973–98. Their analysis suggested that developing countries faced lower income elasticities of demand than industrialised countries and that generally the Marshall-Lerner condition was satisfied.

Two estimates of Papua New Guinea's export price elasticities of demand have been provided by Gibson (1994) and Kauzi (1992). Gibson's research—in contrast with that of Kauzi—found that the own-price elasticity of export demand for coffee and cocoa was significantly greater than one, casting doubt on the cross-sector validity of Kauzi's inelastic price elasticity of demand estimate.

As literature directly related to Papua New Guinea's exports is unavailable, we review research on countries with export compositions comparable with that of Papua New Guinea's mineral and non-mineral sectors. We note this to be less than ideal due to the differences in the composition of exports, trading partners and techniques used; however, it is likely to provide insight for our research.

Papua New Guinea's major mineral exports include copper, gold and petroleum (BPNG 2006a). Economies with similar export compositions include Peru, Chile and Zambia (CIA 2007). Estimated price and income elasticities were examined for Peru from the work of Fullerton, jr, Sawyer and Sprinkle (1999) and Senhadji and Montenegro (1999). Chile's elasticity estimates were taken from Senhadji and Montenegro (1999) and Fullerton, jr, Sawyer and Sprinkle (1999). Estimates for Zambia were taken from research by Arize (1987) and Tegene (1989). Typically, mineral-exporting coun-



tries were found to face inelastic income and price elasticities of demand for their exports. Therefore, it is likely that Papua New Guinea's mineral and petroleum sector will exhibit inelastic price and income elasticities of export demand.

Papua New Guinea's major non-mineral exports include palm-oil, coffee and cocoa (BPNG 2006a). As those countries that export a large proportion of agricultural commodities are expected to face similar demand elasticities, Cote d'Ivoire, Fiji and Paraguay (CIA 2007) have been selected for comparison. Price and income elasticity estimates for Cote d'Ivoire and Paraguay were taken from Senhadji and Montenegro (1999). Estimates for Fiji were taken from Asafu-Adjaye (1999), Prasad (2000) and Rao and Singh (2007). Estimated income elasticities for the non-mineral sector for Fiji and Paraguay were above unity—although this conflicts with the results for Cote d'Ivoire. The review of these results appears to provide much less of a consensus than for the mineral sector, while the range of estimates calculated by Rao and Singh suggests a number of elasticities are plausible for Papua New Guinea's non-mineral sector.

Overall, the literature suggests low price and income elasticities of demand for mineral and petroleum exports, but there is no agreement regarding the likely magnitude of the non-mineral sector elasticities. The results of Kauzi (1992) imply a low price elasticity for Papua New Guinea's aggregate exports, but this result provides little insight into the sector-specific elasticities that Papua New Guinea faces.

Institutional background

Papua New Guinea's population is approximately six million, of which 87 per cent lives in rural areas and relies mainly on subsistence agriculture (DFAT 2004). In

2006, GDP was estimated to be US\$4.3 billion; GDP per capita was estimated to be US\$2,751 in purchasing power parity (PPP) terms (DFAT 2006). The country's principal exports are copper, gold, silver, crude oil, forestry related goods, palm-oil, coffee and cocoa. The domestic currency, the kina, had an average exchange value of US\$0.32 in 2006 (BPNG 2007).

Trade has been a major driver of economic growth at times of strong commodity prices. Despite the sharp increases in the kina price of gold, copper and petroleum, however, there has been little export volume growth in the mineral sector. In contrast, the volumes of non-mineral commodities have increased steadily. Since the opening of the first large-scale, open-pit mine in Panguna in 1972, the mining and petroleum industry has achieved little of its original vision as a panacea for development, despite the sector's significant generation of export revenue.

In order of importance, the main contributors to agricultural exports are palm-oil, coffee and cocoa. Export volumes of these commodities have increased steadily since the early 1980s and together they have accounted for 85–90 per cent of agricultural export revenues since 2000. Other agricultural exports include copra-oil, tea, rubber and copra. The lack of disaggregated revenue data for 'other' exports makes it difficult to analyse individual components, although this category contains a negligible quantity of manufactured goods.

Individually, agriculture accounted for 13 per cent of total export revenue in 2006, forestry for 4 per cent and fisheries for 1 per cent. Export volumes have grown in all three industries (BPNG 2007). Despite the non-mining sector's small contribution to export revenue, it accounts for 28–30 per cent of GDP and approximately 40 per cent of formal employment—levels significantly higher than those of the minerals and petroleum sector (DFAT 2004; ERI 2003).



Papua New Guinea has enjoyed strong demand for its exports from Australia and Japan, which together accounted for 55 per cent of total exports in 2006 and an average of 52 per cent since 1980 (BPNG 2003, 2004, 2006a). Exports to Australia and Japan are principally petroleum, minerals and coffee (DFAT 2006; PIC 2007). The remaining major export destinations as of 2006 were Germany, Korea, the United Kingdom, China and the Philippines.

Methodology and data

This study estimates export demand equations for Papua New Guinea's mineral sector, its non-mineral sector and for total exports. We follow the approach of similar studies and use a single-equation specification. We assume that demand for Papua New Guinea's exports is determined by the relative price of exports and the real income of importers. We assume a Cobb-Douglas functional form and perform a logarithmic transformation. The export demand function is specified in Equation 1.

$$\ln X_d^t = \beta_0 + \beta_1 \ln \left[\frac{P_d^t}{E^t \times P_f^t} \right] + \beta_2 \ln Y_w^t + e_t \quad (1)$$

In Equation 1, X_d^t = export volume; P_d^t = kina price of Papua New Guinea's exports; E^t = kina price of foreign currency; P_f^t = foreign currency price of similar foreign goods to the exports, defined within the

dependent variable; $\left[\frac{P_d^t}{E^t \times P_f^t} \right]$ = relative price

of exports, herein referred to as 'RP'; e_t = random error; and Y_w^t = real world income.

Data have been sourced from the Bank of Papua New Guinea's statistical tables (BPNG 2007) and the International Monetary Fund's International Financial Statistics database (IMF 2007).

Export volumes were generated by deflating export revenue for mineral, non-mineral and total exports by the corresponding export price indices. Alternative relative price (RP) variables were generated using the series most likely to proxy Papua New Guinea's export prices (P_d) and the foreign price of comparable goods (P_f). Individual relative price variables were assessed according to their explanatory power and theoretical relevance.

For total exports, the Bank of Papua New Guinea's export price index and the IMF's commodity price index were used and tested against Papua New Guinea's real effective exchange rate (IMF 2007). The real effective exchange rate was chosen as it provided a broader measure of the price movements of competing goods on the world market and because of its explanatory power.

For the non-mineral sector, relative price variables were constructed using the Bank of Papua New Guinea's non-mineral export price index for the price of exports and the IMF's commodity price index and non-fuel primary commodity index for the prices of comparable world commodities. The IMF's real effective exchange rate was selected out of the three chiefly due to its stronger power in explaining non-mineral export volumes.

Relative price variables for mineral exports were constructed using the Bank of Papua New Guinea's mineral export price index for the price of mineral exports and the IMF's commodity price index, non-fuel primary commodity price index and metal price index for the prices of similar foreign goods. Of the four series, the relative price variables calculated using the Bank of Papua New Guinea's mineral export price index



and the IMF's metal price index were chosen due to their stronger explanatory power.

World income variables trialled included: nominal world imports, the world industrial production index, the trade-weighted real GDP of importers and Australia's real GDP. Australia's real GDP was used as a proxy for world income as it was found to provide the best results.

Engle and Granger (1987) suggest that non-stationary series can be used in levels in regression analysis provided that their linear combination results in a stationary error term. In such a case, the series is said to be co-integrated and ordinary least squares (OLS) regression can be validly employed (Enders 2004). As world income and relative prices are expected to jointly define the path of export volumes, divergence of export volumes from the jointly defined co-integrated path will be transitory and tend to self-correct.

In practice, testing for co-integration is a matter of examining how export volumes deviate from the estimated long-term influence of income and relative price. This test is carried out by taking the original export demand function and solving for ' e_t ' (Equation 2).

$$e_t = \ln X_d^t - \beta_0 - \beta_1 \ln \left[\frac{P_d^t}{E^t \cdot P_f^t} \right] - \beta_2 \ln Y_w^t \quad (2)$$

If the system is co-integrated, the error term will reflect only temporary movements around a long-term path—that is, it would be stationary and approximate white noise (Hill, Griffiths and Judge 2001).

To obtain short-run elasticities and adjustment parameters, we need to estimate error-correction equations. This involves including the lagged error term e_{t-1} within a short-run model so that it has the form of Equation 3.

$$\Delta \ln X_d^t = \alpha_1 \Delta \ln \left[\frac{P_d^t}{E^t \cdot P_f^t} \right] + \alpha_2 \Delta \ln Y_w^t + \alpha_3 \ln e_{t-1} + u_t \quad (3)$$

The error-correction model's coefficients, α_1 and α_2 , represent the percentage impacts of changes in relative price and foreign income on export volumes. The coefficient α_3 provides an estimate of the export demand's rate of convergence to the estimated co-integrated path.

Results

The estimated specification is essentially the same for all three long-run and short-run models. As a result of initial breakpoint and specification tests, however, additional variables such as trend terms and dummy variables were added to achieve more reliable estimates. Dummies and trend variables have not been included within the error-correction equations.

Long-run mineral and petroleum exports model

The mineral sector export demand function contains a linear trend term (T) and a dummy variable (MS) to capture supply disruptions in 1997 and 1998 as a result of drought and in late 2006 as a result of poor weather, maintenance problems and strikes (BPNG 2006a, 2006b). It was expected that the trend variable would carry a negative sign due to the downward trend in mineral and petroleum export volumes. A positive relationship was expected between world income and export volumes, while a negative sign was expected for the relative price variable. All variables were found to be statistically significant and carried the expected signs, except for the world income variable. The model explains approximately 70 per cent



of the total variation of mineral export sector (Table 1).

The coefficient for the relative price variable indicates that a 1 per cent increase (decrease) in the relative price of mineral and petroleum exports would result in an approximately 0.3 per cent decrease (increase) in export volumes. The inelastic relative price coefficient is consistent with studies of countries with a relatively high proportion of mineral exports such as Chile and Peru (Senhadji and Montenegro 1999). The low price elasticity of demand is plausible for a number of reasons. First, as goods such as copper, gold and crude oil are likely to have few or no substitutes, cross-price elasticities are likely to be low. Own-price elasticities are likely to be low due to the costs and time required to adapt production processes to either improve efficiency to compensate for a price increase or switch input sources, particularly within a quarterly time frame. Lastly, it is probable that most mineral and petroleum exports are sold through long-term contracts (DFAT 2004). Such arrangements would result in a low responsiveness to price, particularly if importers hedged against foreign exchange risk.

The insignificance of the income variable could be a result of several factors. First, Australia's real GDP might not be an adequate proxy for the income movements of Papua New Guinea's mineral and petroleum importers. An alternative explanation could be that increased copper and gold production in Papua New Guinea's main trading partner, Australia, has offset any income effect—particularly if domestic production of these goods is not discernibly associated with income movements (Mudd 2005). It is also probable that importers are more concerned with 'permanent' or 'expected' real income levels than with current real income when selecting production inputs.

The inclusion of the trend variable was necessary to take account of declining output during the sample period. We opted to retain the trend variable even though it was found to be insignificant. The inclusion of the dummy variable (MS) was found to improve the model results significantly. The dummy variable was found to be statistically significant and negative. This is to be expected as both supply shocks during the sample period resulted in temporary declines in export volumes due to mine closures.

All variables in the error-correction model are in first differences except the error-correction term. The results are given in Table 2.

The statistically significant error-correction term reaffirms the validity of the co-integration results. The results suggest that any divergence from the long-term equilibrium path will be corrected by approximately 83 per cent per quarter.

Long-run estimates for non-mineral (forestry, farming and fishery) exports

The long-run export demand function for the non-mineral sector contains three variables. In addition to the price and income variables, a dummy (E) is included to capture the impact of drought on the sector. A negative coefficient is expected for the dummy variable. All variables except for the relative price variable have the expected signs and are statistically significant. The results are presented in Table 3.

The unexpected positive sign of the price variable is puzzling, although similar results have previously been obtained by comparable studies (see Bahmani-Oskooee and Kara 2005). One possible explanation is that positive supply responses dominated during periods of relative price changes. This could be the case for a number of reasons. Firstly, there has been strong growth in the volume of exports since 1994,

**Table 1 Long-run elasticities of mineral and petroleum export**

Variable	Coefficient	Standard error	t-statistic
Intercept	15.6081	7.3432	2.1256**
$\ln RP_7$	-0.3302	0.1394	-2.3679**
$\ln Y_w^t$	-1.1989	1.1344	-1.0568
MS	-0.2964	0.0406	-7.3060***
T	0.0058	0.0103	0.5629

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 47} = 1.678$; $t_{0.025, 47} = 2.012$; $t_{0.005, 47} = 2.685$; $R^2 = 0.72$; adjusted $R^2 = 0.695$.

Table 2 Short-run estimates for the mineral sector

Variable	Coefficient	Standard error	t-statistic
$\ln \Delta RP_7$	-0.2087	0.1834	-1.1377
$\ln \Delta Y_w^t$	-0.8666	1.4197	-0.6104
e_{t-1}^M	-0.8262	0.1766	-4.6791***

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 48} = 1.677$; $t_{0.025, 48} = 2.01$; $t_{0.005, 48} = 2.68$; $R^2 = 0.32$; adjusted $R^2 = 0.29$.

Table 3 Long-run estimates for non-mineral sector exports

Variable	Coefficient	Standard error	t-statistic
Intercept	-7.0446	2.1840	-3.2256***
$\ln RP$	1.7070	0.2497	6.8367***
$\ln Y_w^t$	0.7953	0.1945	4.0885***
E	-0.1515	0.0597	-2.5383**

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 48} = 1.677$; $t_{0.025, 48} = 2.011$; $t_{0.005, 48} = 2.68$; $R^2 = 0.52$; adjusted $R^2 = 0.49$.



particularly in the case of palm-oil. Second, the removal of the institutionally fixed minimum rural wage resulted in both a rise in private investment and likely greater utilisation of labour (DFAT 2004). Third, the significant devaluation of the kina alongside improved macroeconomic stability during the period also resulted in large improvements in international competitiveness (Kannapiran and Fleming 1999). Fourth, there was also an improvement in labour and land productivity during the period (Fleming 2007).

The positive income elasticity suggests that an increase (decrease) of world income by 1 per cent will result in a 0.8 per cent increase (decrease) in trade volumes. The income inelasticity is consistent with similar research on developing nations (Bahmani-Oskooee and Kara 2005). The dummy variable (E) is both significant and negative, reflecting the fall in export volumes resulting from Cyclone Justine and large-scale drought in 1997 and 1998. The dummy's inclusion was found to improve the trade model results.

Short-run estimates were obtained via an error-correction model (Table 4). The statistically significant and negative error-correction term indicates that any deviation from the long-term equilibrium will be corrected at a rate of 80 per cent per quarter.

Total export model

The long-run total export demand function contains a linear trend (T), a quadratic trend (T²), the relative price variable (RP) and income (Y). The total export model was estimated using the 'Newey-West' procedure to correct for serial correlation (Brooks 2005). The results are provided in Table 5. The model explains more than 60 per cent of the variation in total exports. The price and income variables have the expected signs, but only the income coefficient is statistically significant (at the 5 per cent level).

The reason for the statistically insignificant price variable is not clear. One could attribute it to the wide range of goods exported by Papua New Guinea and the difficulty of representing them with a single aggregate relative price variable.

The highly significant income variable suggests that export volumes exhibit a high level of income elasticity with a 1 per cent increase (decrease) in world GDP resulting in a more than 3 per cent increase (decrease) in export volumes. The magnitude of the coefficient was unexpected due to income elasticities being typically below one for primary commodities (Naya 1967; Bahmani-Oskooee and Kara 2005).

The results for the error-correction model are reported in Table 6. The error-correction model explains 23 per cent of variations in the movement of export volumes. All but the error-correction term were found to be insignificant.

The error-correction term suggests that any movement away from the long-term equilibrium relationship will be corrected by 54 per cent per quarter. An interesting feature of this result is that it suggests a slower convergence to the co-integrating relationship than for both the mineral and non-mineral error-correction models. A possible reason for this result is that as relative prices are found to be insignificant, the co-integrated relationship has been estimated by income alone. If the relative price does influence the long-term path of the export volume, the estimate for the rate of convergence to a path defined only by income is likely to be relatively low.

Conclusion

The purpose of this study was to estimate sector-specific export demand elasticities for Papua New Guinea. We employed quarterly data from 1994 to 2006 under a co-integrated



Table 4 Short-run estimates for the non-mineral sector

Variable	Coefficient	Standard error	t-statistic
$\ln \Delta RP$	0.9576	0.3426	2.7950***
$\ln \Delta Y_w^t$	0.3112	1.8188	0.1711
e_{t-1}^F	-0.7941	0.1360	-5.8388***

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 48} = 1.677$; $t_{0.025, 48} = 2.010$; $t_{0.005, 48} = 2.68$; $R^2 = 0.43$; adjusted $R^2 = 0.41$.

Table 5 Long-run estimates for total exports

Variable	Coefficient	Standard error	t-statistic
Intercept	-13.7499	8.1651	-1.6840*
$\ln RP$	-0.1820	0.2656	-0.6853
$\ln Y_w^t$	3.5953	1.2937	2.7791***
T	-0.0602	0.0174	-3.4708***
T^2	0.0004	0.0002	2.3963**

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 47} = 1.678$; $t_{0.025, 47} = 2.012$; $t_{0.005, 47} = 2.685$; $R^2 = 0.64$; adjusted $R^2 = 0.61$.

Table 6 Short-run results for the total export demand function

	Coefficient	Standard error	t-statistic
$\ln \Delta RP$	0.0219	0.2306	0.0948
$\ln \Delta Y_w^t$	-0.3263	1.2549	-0.2600
e_{t-1}	-0.5369	0.1410	-3.8081***

* indicates significance at the 10 per cent level

** indicates significance at the 5 per cent level

*** indicates significance at the 1 per cent level

Notes: $t_{0.05, 48} = 1.677$; $t_{0.025, 48} = 2.01$; $t_{0.005, 48} = 2.68$; $R^2 = 0.229$; adjusted $R^2 = 0.197$.



framework. The results suggest that individual export sectors react significantly differently to a given change in relative prices or economic growth. Long-run export elasticities were also found to differ from short-run elasticities. A key weakness of the study is its use of a single-equation functional form.

In the long-term, export volumes are explained predominantly by movements in world real income and relative prices. It was found that divergence from this long-run equilibrium path for farming, forestry and fishery exports and mineral and petroleum exports is corrected at a rate of approximately 80 per cent per quarter. It was also found that total exports were determined in the long-term by world income, with any departure from the long-term path being corrected at approximately 54 per cent per quarter. It was found that a co-integrating relationship existed in all three cases.

Provided the estimated relationship holds, a currency appreciation would result in an elastic expansion of non-mineral exports and an inelastic decline in mineral export volumes. Under such circumstances, we expect that any decline in mineral and petroleum exports would be offset by an increase in total revenue and taxation revenue arising from *ad-valorem* export taxes. Because Papua New Guinea is a price-taker on the world market, this response is likely to be transitory, with appreciation threatening the competitiveness of Papua New Guinea's export sector.

For the non-mineral sector, the positive price elasticity suggests that exporters will react strongly to price signals. The income inelasticity suggests that world demand for Papua New Guinea's non-mineral exports has grown more slowly than world real income growth and that the sector can serve as a viable long-term driver of economic growth only while exporters can sustain price competition.

References

- Arize, A., 1987. 'The supply and demand for imports and exports in a simultaneous model', *Applied Economics*, 19(9):1,233–47.
- Asafu-Adjaye, J., 1999. *Exchange rate variability and export growth in Fiji*, Asia Pacific School of Economics and Management Working Papers, The Australian National University, Canberra.
- Bahmani-Oskooee, M. and Kara, O., 2005. 'Income and price elasticities of trade: some new estimates', *The International Trade Journal*, 19(2):165–78.
- Baxter, M., 2001. *Enclaves or Equity: the rural crisis and development choice in Papua New Guinea*, (54), Australian Agency for International Development, Canberra.
- Bank of Papua New Guinea (BPNG), 2003. *Quarterly Economic Bulletin*, March 2003, Bank of Papua New Guinea, Port Moresby.
- , 2004. *Quarterly Economic Bulletin*, June, Bank of Papua New Guinea, Port Moresby.
- , 2006a. *Quarterly Economic Bulletin*, December, Bank of Papua New Guinea, Port Moresby.
- , 2006b. *Quarterly Economic Bulletin*, June, Bank of Papua New Guinea, Port Moresby.
- , 2007. *Quarterly Economic Bulletin*, December, Bank of Papua New Guinea, Port Moresby.
- Brooks, C., 2005. *Introductory Econometrics for Finance*, Cambridge University Press, New York.
- Central Intelligence Agency (CIA), 2007. *CIA: the world factbook*, Central



- Intelligence Agency, Washington, DC. Available from <https://www.cia.gov/library/publications/the-world-factbook/index.html>
- Department of Foreign Affairs and Trade (DFAT), 2004. *Papua New Guinea: the road ahead*, Department of Foreign Affairs and Trade, Commonwealth of Australia, Canberra.
- , 2006. *Papua New Guinea Fact Sheet*, Department of Foreign Affairs and Trade, Commonwealth of Australia, Canberra.
- Edwards, S., 1991. *Trade Orientation, Distortions and Growth in Developing Countries*, National Bureau of Economic Research, Cambridge, Mass.
- Enders, W., 2004. *Applied Econometric Time Series*, Leyh Publishing LLC, Texas.
- Engle, R.F. and Granger, C.W., 1987. 'Cointegration and error correction: representation, estimation and testing', *Econometrica*, 55(2):251–76.
- Enterprise Research Institute (ERI), 2003. *Papua New Guinea: a private sector assessment 'The realities of crisis'*, The Enterprise Research Institute, Colorado.
- Fleming, E., 2007. 'Agricultural productivity change in Pacific island countries', *Pacific Economic Bulletin*, 22(3):32–47.
- Fullerton, T.M., jr, Sawyer, W.C. and Sprinkle, R.L., 1999. 'Latin American trade elasticities', *Journal of Economics and Finance*, 23 (Summer):143–56.
- Gibson, J., 1994. 'The price elasticity of demand for Papua New Guinea exports of cocoa and coffee', *Papua and New Guinea Agricultural Journal of Agriculture, Forestry and Fisheries*, 37(2):67–75.
- Hill, C., Griffiths, B. and Judge, G., 2001. *Undergraduate Econometrics*, Second edition, John Wiley and Sons, New Jersey.
- Houthakker, H.S. and Magee, S.P., 1969. 'Income and price elasticities in world trade', *The Review of Economics and Statistics*, 51(2):111–25.
- International Monetary Fund (IMF), 2007. *Online International Financial Statistics Database*, International Monetary Fund, Washington, DC. Available from <http://www.imfstatistics.org/imf/>
- Kannapiran, C.A. and Fleming, E.M., 1999. *Competitiveness and Comparative Advantage of Tree Crop Smallholdings in Papua New Guinea*, University of New England, Armidale, NSW.
- Kauzi, G., 1992. 'The pros and cons of devaluation', *Business Times*, Port Moresby.
- Mudd, G.M., 2005. 'An assessment of the sustainability of the mining industry in Australia', *Proceedings of the Environmental Engineering and Sustainability 2005 National Conference*, Society for Sustainability and Environmental Engineering (Engineers Australia), Sydney:18–19.
- Murray, T. and Ginman, P.J., 1975. 'An empirical examination of the traditional aggregate import demand model', *Review of Economics and Statistics*, 58(1).
- Naya, S., 1967. 'The commodity pattern and export performance of developing Asian countries to the developed areas', *Economic Development and Cultural Change*, 15(4):420–37.
- Paulino, A.S. and Thirlwall, A.P., 2004. 'The impact of trade liberalization on exports, imports, and the balance of payments of developing countries', *The Economic Journal*, 114:50–72.
- Pacific Island Centre (PIC), 2007. *Trade Statistics: 'Japan's imports from Papua*



- New Guinea', South Pacific, Pacific Island Centre, Fiji. Available from http://www.pic.or.jp/en/stats/im_png.htm*
- Prasad, S., 2000. *Determinants of Exports in Fiji*, Economics Department, Reserve Bank of Fiji, Suva.
- Rao, B. and Singh, R., 2007. 'Estimating export equations', *Applied Economic Letters*:1–4.
- Senhadji, A.S. and Montenegro, C.E., 1999. *Time series analysis of export demand equations: a cross-country analysis*, IMF Staff Papers, International Monetary Fund, Washington, DC, 46(3).
- Tegene, A., 1989. 'On the effects of relative prices and effective exchange rates on trade flows of LDCs', *Applied Economics*, 21(11):1,447–63.

Acknowledgment

This article has benefited from the comments of two anonymous referees and from conference participants at the thirty-seventh Australian Conference of Economists, Gold Coast, Australia.